central, bottleneck role in all other telecommunications and related markets.

Independently controlled and managed Bell System operating companies would continue to originate and terminate interexchange telecommunications services for the Long Lines Dept. of AT&T, as well as for competing interexchange carriers. Similarly, such companies would presumably continue to purchase a substantial share of the telecommunications equipment and research services they require from Western Electric and Bell Telephone Laboratories. But they would enjoy greater freedom than now exists to procure such equipment and services from other vendors, if they could obtain better performance or lower costs that way. In turn, both Western Electric and Bell Telephone Laboratories would be required to market their equipment and services to other telecommunications operating companies and consumers.

In opposing the creation of arm's-length relationships between local operating companies and Long Lines, Western Electric and Bell Laboratories, AT&T management contends that it must retain the ultimate authority for "network management" to ensure that this job is done satisfactorily. This contention merits some discussion.

There is at present not one, but many telecommunications networks within the United States, both at the local exchange and the interexchange level. Many of these networks are operated by companies outside the Bell System—independent telephone companies, international carriers, specialized carriers, airlines, public utilities, government agencies, satellite carriers, etc. Most of these networks interconnect satisfactorily with the local exchange and/or interexchange networks operated by Bell System operating companies and AT&T Long Lines. Many provide either basic or specialized voice telephone services in conjunction with public message telephone operations of the local Bell System companies. Since these are independent and, in some instances, competitive telecommunications carriers, they quite clearly must and do coordinate satisfactorily with Bell operating companies and Long Lines according to "arm's-length" arrangements. Thus, there seems to be no need for assigning ultimate authority for "network management" to any single organization.

AT&T also contends that accurate cost accounting can be an effective alternative to any form of corporate restructuring. The argument is that this will prevent cross-subsidization and, inferentially, other anticompetitive practices. However, even AT&T acknowledges that it is impossible to determine through its present accounting even the cost of major services, let alone the cost of particular service offerings. Five to 10 years would be required to develop and implement a new cost-accounting system of yet undetermined accuracy and validity. Greatly improved cost accounting capabilities are clearly essential, particularly for those dominant telecommunications carriers that provide a variety of services subject to competition. But cost-accounting systems, which are necessarily arbitrary and essentially retrospective, are not an effective substitute for competitive forces as a means of ensuring fair prices. This is particularly true in markets characterized by dynamic technological and market developments, as are most telecommunications markets. Moreover, cost accounting systems provide virtually no assistance in preventing other anticompetitive practices such as interconnection constraints, etc. ◆

Walter Hinchman does consulting work in telecommunication services. He established Walter Hinchman Associates Inc. in 1978. Prior to that, he was Common Carrier Bureau Chief for the Federal Communications Commission. He organized and managed the office of Plans and Policy, responsible for advising and assisting the commission in communication policy, development, and implementation. In 1970, he was assistant director of the Office of Telecommunications Policy. In 1968, Mr. Hinchman was a member of President Johnson's Task Force on Communications Policy with responsibilities for policy analyses, recommendations concerning satellite communications, common-carrier communication and radio spectrum management. In 1966-67, he served as a Commerce Science and Technology Fellow in the Executive Office of the President. From 1955-66, he was employed by the U.S. Navy, Raytheon Corp., and the U.S. Dept. of Commerce for the development of radio and communication systems. He majored in physics at Ohio State University.

On Bell: II. The system is sound

'It ain't broke, so don't fix it,' reflects the sentiments of an eminent Bell Labs emeritus executive

Breaking up the Bell System in a way that I regard as arbitrary would make it harder, rather than easier, to harness new technology to the service of users. At present, telecommunications switching and transmission, information processing, and communication are all going digital. Unified development of this common technology would be the most efficient path to follow, not fragmented development through an enforced diversity of sources.

John R. Pierce
California Institute of Technology

And that is only one major reason why I am opposed to complete restructuring of the Bell System.

Here is another: American communications services, including the telephone, are better, more reliable, cheaper, and easier to obtain than those in any other country. I feel that changes as drastic as those proposed by Walter Hinchman would have profound effects on this efficiency and we have only Mr. Hinchman's arguments that the changes would be beneficial.

He proposes the division of all American communications and information equipment and services into four areas:

1. The manufacture of equipment for installation on the

customer premises and to be used exclusively by customers.

2. Provision for local exchange services.
3. Provision for interexchange service.
4. Provision for information services.

There is a good deal of talk about avoiding any cross-subsidization if one organization operates in more than one field. This is to be attained through fully separated, "arm's-length" subsidiaries. Nothing is said about the difficulties of resolving technical problems at arm's length.

Even now, there is some overlap between local exchange service and interexchange service. Today, interchange switching centers are also used for local exchange switching. Under arm's-length operations, there would be multiple duplication of equipment that would be employed less efficiently to work on less load—and an attendant increase of operations across the arm's-length boundaries. Would such competition really make things cheaper? I believe that the price of precluding cross-subsidization would be high.

Digital techniques taking over

Let us consider present electronic technologies and future possibilities. Communication is rapidly going digital in all its aspects—voice, facsimile, and video, as well as all of data. We are moving into a world in which transmission, switching, and information processing will all deal with streams of bits processed by scarcely distinguishable large-scale integrated circuits. In the long run, signals will be converted to digital bit streams by the equipment on the customer's premises, whether the signals are telephone, video, or data keyboard. They will be switched, stored, and processed in common, or similar manners at nodes along the communication path—that is, unless some action such as that proposed to realign the Bell system prevents this.

Electronic control—the computer, if you will—is getting cheaper and cheaper. Adding more capability to the computer in a customer's set or a switching system costs very little. With some cheap capabilities, it is possible to store voice or data calls, reroute calls to other numbers, provide via voice or alphanumeric display the time, weather, wake-up calls, and plane schedules, and do all sorts of other data processing.

It is possible that such services could be provided much more cheaply and simply by augmented common control of switching equipment rather than by bringing equipment belonging to some information processing entity to the local telephone office. It seems to me that a proposal to separate U.S. telecommunications into four markets might make it impossible to offer economically attractive information services via a combination of the customer's set and the local exchange equipment. It might also lead to endless regulatory disputes and litigation.

Further, the great sweep of digital art is toward hierarchical organization. A small machine does a lot, but it passes other tasks onto a machine at a higher level in the hierarchy. In fact, that's how present telephone switching works. Among its switching hierarchies are many classes of offices, including local offices, tandem offices, and toll offices. Above all of these is a network control function that establishes the traffic routing best suited for time of day or emergency conditions.

Now, to provide augmented communications services, including those that require information retrieval, it seems plausible that some functions should be performed at the local office and some at higher levels. It simply isn't sound to separate local service from interexchange service on nontechnical grounds. Any hampering of unity between the services could well make the overall service awkward and costly.

Vast funds for development needed

There are other reasons for not dismembering a going concern. It will take a lot of money and expertise to realize potentialities we can already foresee: full-duplex, 64-kb transmission of both data and voice to offices and homes, to be followed by full-duplex, switched digital circuits of video capacity to offices and homes via optical fibers—and all of this integrated in such a way as to provide communication and information processing services of national scope. Will such goals be attained more quickly or more easily by splitting the Bell System resources into four categories and many more parts?

In any integrated world of integrated circuits and integrated services, the idea of a special category of manufacturer who supplies only communication equipment for the subscriber's premises, to be used by the subscriber, seems curious. How many of the functions that are part of the complicated interactions in information and communications can be best performed by equipment at a local office or a toll office or some other remote place that serves many subscribers? It seems to me that delimiting a simple and external boundary in the realm of manufacture (and I suppose of development and design) would constrain the future of communication and information.

Under Mr. Hinchman's reordering of telecommunications, AT&T, Western Electric, and Bell Laboratories would be left with the task of interexchange service, whatever that might mean or become in such a compartmented world. The many separately administered telephone operating companies might pay AT&T for engineering, coordinating or research services, if they wished and if local regulatory commissions allowed them to, or they might not. The only assured funds for any long-term research and development would come from AT&T's interexchange service, but this service would be carefully isolated from the needs and desires of individual subscribers and from the full potentialities of the electronic revolution.

It would also be isolated from Western Electric's sale of equipment to one and all—except equipment on the customer's premises for the customers' use. Who would be concerned with imagining and devising something that would bring together all sorts of facilities to offer some new and attractive range of services to customers? Well, who?

The present system works

As a Bell System employee for 35 years (until 1971), I saw telecommunications as a continual struggle to use new means to provide better services, new and old. I didn't just work on plain old telephone service; I worked on microwave radio and communication satellites, digital transmission, digital switching, and data transmission.

I saw all sorts of new paths to be opened. I saw transistors replace vacuum tubes and mechanical switching replaced by electronic switching. I saw all sorts of obstacles to be overcome. Not all of these were technical.

The Bell System has fought hard for the right to use new technologies and to provide new services. It won the right to use radio, including microwave radio. After launching the first successful communication satellite, it was legislated out

of the international satellite business. The outcome of a long fight for permission to provide adequate mobile telephone service seems still in doubt. Customer-attractive services, including Telepak and WATS, were attacked on the basis of both service and rates. Also, regulations concerning the entry of other companies into the common-carrier field appear to have been rigged not so much to foster competition as to try to assure that non-Bell carriers could not lose.

I found the Bell System eternally and painfully sensitive to two things: to regulatory efforts that would prevent it from using new technologies and providing new services, and to customer complaints, which sent shudders through the organization from bottom to top.

Consider the technological progress made under the Bell System, even before World War II. By then, it had provided many special and very sophisticated teletypewriter systems to banks, brokers, hotels, information systems, and credit bureaus, as well as teletypewriter exchange service (TWX).

The telephone had become intelligible through years of psychoacoustic and electronic research. Speech was being carried between one phone and any other in the whole country—to Bell or non-Bell subscribers—by multiplex systems using negative-feedback amplifiers and crystal oscillators and filters. Common-control switching, which later made universal subscriber toll dialing possible, was already in use. The switched telephone network was then the most complex thing ever put together by man.

Some competition exists today

Today, U.S. communications have come, gradually, to encompass increasing amounts of facsimile, video, data, and information processing as well as voice. The potentialities of the future are multitudinous, but not entirely clear. The Bell System serves about 85 percent of phone customers (a declining percentage) and about 50 percent of the geographical area of the United States. It provides such attractive marketable communication services as the regulators will allow it to.

Unlike government telecommunication administrations or government owned telecommunications organizations, the Bell System has not only its own research facilities (less than a tenth of the activity of Bell Laboratories), but also its own development organization (most of the activity of Bell Laboratories) and its own manufacturing facilities (Western Electric). Some, at least, judge Western Electric's function to be both unique and important to American telephony.

"What the NTT needs is an Eastern Electric," a Japanese friend once told me very seriously.

Western Electric has an excellent record of rising productivity. Bell operating companies usually buy most of their transmission, switching, and network control equipment from Western, but they also purchase a substantial amount from other companies. Western makes telephone sets, but does not sell them to subscribers, who may buy the sets from other manufacturers.

While Bell Laboratories and Western Electric have grown, the American electronics industry has grown much faster. Bell Laboratories and Western Electric constitute a continually shrinking fraction of American electronics research, development, and production.

Western still sells much equipment to the Bell System operating companies a good deal cheaper than it can be purchased on the outside market, though there are areas in which other suppliers are competitive in price. Through Bell Laboratories development and Western design, the equipment produced is of high quality and reliability. Through the link between the operating companies, AT&T, Bell Laboratories, and Western, the Bell System responds to opportunities and needs for new services, though the actual provision of new services is often delayed substantially by the regulatory process.

While I won't offer detailed arguments, I really don't think that Bell Laboratories, with its broad sweep of imagination and aspiration, science, and application, could survive under major restructuring of the Bell System—certainly not in anything like the form in which we have known it. What would happen to that research where the transistor, the solar cell, the magnetic-bubble memory, and charge-coupled devices were invented? Where cosmic background radiation was discovered? Where Davidson, Anderson, Penzias, and Wilson did work that won them Nobel Prizes? Isolated from contact with the realities of manufacture and service, what would become of it? Nothing good.

Why tamper with success?

Why should anyone feel an urge to change something that works very well? The experience of those who have used the communications sytems of other nations is that American communications—including data and information services as well as the telephone service—are better, more reliable, cheaper, and easier to obtain here than abroad. There is always a chance that drastic changes might make them worse.

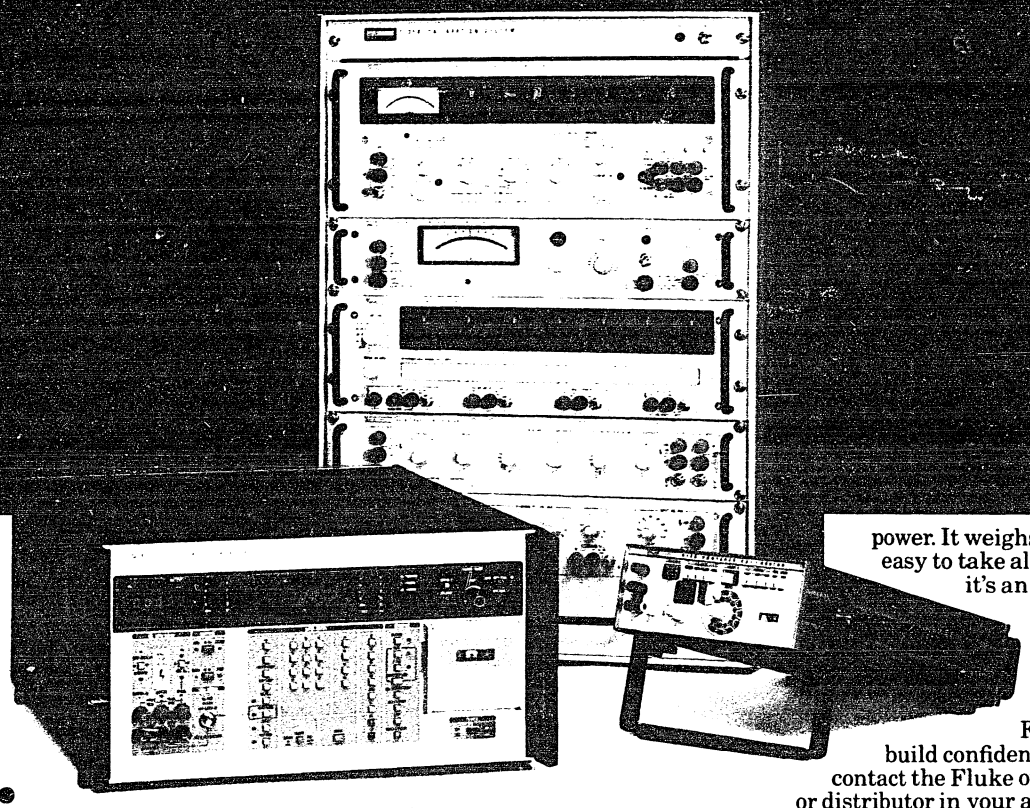
We live in an imperfect world in which nothing is ever quite right. Different people see things differently. Some feel that what stands in the way of perfection, or a better approach to it, is the existence of malevolent people, forces, groups or organizations, and that if these were closely constrained or eliminated, things would go better. I believe that the actions springing from such a world view are generally not constructive.

I regard the real challenge of the day as establishing that very difficult link between advanced science at one end and man's comfortable and effective use of technology at the other. Such a link must involve two-way communication and cooperation over difficult barriers between research, development, manufacture, operation, and the provision of satisfactory service to individuals. I believe that the Bell System in its present form has been very effective in linking these diverse aspects of communication—from science clear through to service. ◆

John R. Pierce (LF) is Professor of Engineering at California Institute of Technology. From 1936 to 1971, he held various positions at Bell Telephone Laboratories including Executive Director of Research, communication sciences division. Dr. Pierce has many honorary degrees and was a member of the President's Science Advisory Committee. Among his awards are: the Marconi International Fellowship, 1979; the Founders Award, National Academy of Engineering, 1977; the Medal of Honor, IEEE, 1975; the Edison Medal, IEEE, 1963. Dr. Pierce is the author and coauthor of numerous books and technical articles. He is a Fellow of the Acoustical Society of America and the American Physical Society. Dr. Pierce received the B.S., M.S., and Ph.D. (1936) degrees from the California Institute of Technology.

Fluke answers tough calibration questions.

Three good ways to build confidence and control costs.



Q: **I need high-accuracy calibration that's directly supported by my primary standards. What can Fluke do for me?**

A: When you need the highest levels of confidence, come to Fluke for the world's finest calibration equipment. The 7105A DC Calibration System, for example, provides voltage accuracy to 5 ppm, ratio accuracy to 0.1 ppm, and stability to 1 ppm per year, all fully-traceable to the National Bureau of Standards. For calibrating ac voltage, our 540B Thermal Transfer Standard is unequaled for traceable measurement, calibrating to 0.01%.

Q: **Most of my lab's workload consists of 3½- and 4½-digit meters, and I'm on a tight budget. Have any answers?**

A: You can cut your measurement costs dramatically with our 5100-series Calibrators. They give you the performance of an entire cal lab—all in one box. And at $7495*, they cost a fraction of a traditional system's price. Each 5100 model provides all the ranges and functions necessary to calibrate most meters—dc and ac volts, current, and resistance.

Reduced initial investment is only part of the story. Operation of the 5100's is both simple and fast. Error, volt/dBm conversions and other complex calculations are computed automatically by the hard-working microprocessor.

For further automation, model 5101B comes equipped with a mini-cassette tape feature that records your cal procedure. The knob-twisting drudgery is gone. Calibration time is reduced to minutes per meter.

To make a 5100 more powerful, team it up with the new 5220A Transconductance Amplifier and the 5205A Precision Power Amplifier. Together they create a high-current, high-voltage calibration system.

Q: **Can you show me a verification instrument that's easy to use in the field or on my production line?**

A: Take a look at our 515A Portable Calibrator. With the rechargeable battery pack, you get eight hours of 30 ppm dc, plus ac and resistance calibration free of line power. It weighs just 13 lbs. so it's easy to take along. At only $2395* it's an economical way to get top verification performance wherever you need it.

For more ways to build confidence and control costs, contact the Fluke office, representative or distributor in your area or call:

800-426-0361

If you prefer, just complete and mail the coupon below.

Circle No. 205

FLUKE®

*U.S. prices only.

IN THE U.S. AND NON-EUROPEAN COUNTRIES:	IN EUROPE:
John Fluke Mfg. Co., Inc. P.O. Box 43210, MS#2B Mountlake Terrace, WA 98043 (206) 774-2481 Telex: 32-0013	Fluke (Holland) B.V. P.O. Box 5053 5004EB Tilburg The Netherlands Tel: (013) 673973 Telex: 52237

I'd like more answers.

- ☐ Please arrange for a demonstration.
- ☐ Please send the latest information on Fluke's calibration instruments.
- ☐ Send enrollment information for Fluke Calibration Seminars.

Name

Title Mail Stop

Company

Address

City State Zip Country

Telephone ( ) Ext.

IEEE 12/79